Chapter 6

Aquatic Communities: Status, Needs, and Goals

6.1 Introduction

This chapter describes and assesses aquatic communities—those of rivers and streams, of inland lakes and ponds, and of Lake Michigan. It reports on the status of the communities and their habitats in terms of their condition and problems, defines goals, and identifies actions needed.

The information presented in this chapter is based on the knowledge of participants in the expert workshops and reviewers of the resulting working papers. Much of the content is based on professional experience, rather than the published literature, and is provided to give an indication of priority and direction for future conservation work. Workshop reports on which this chapter is based can be found on the Chicago Wilderness web site (www.chiwild.org). Each of the aquatic communities was examined by a different assessment process, as described in each section.

The Illinois Environmental Protection Agency lists 76 streams within the Illinois portion of the Chicago Wilderness region (IEPA 1996). In addition, there are approximately 20 streams in the Indiana and Wisconsin portions. Each stream's watershed boundary can be mapped to help delineate important water resource areas for biodiversity protection and recovery planning. These watersheds are the basic management units for determining recovery goals and actions for aquatic biodiversity.

The following sections describe the streams of Chicago Wilderness in terms of their general descriptive classification, protection and recovery goals, quality assessment, prioritization, threats, and recommended actions.

6.2 Stream communities—status, recovery goals, and recommended actions

6.2.1 Stream classification

Stream ecosystems within watersheds of the Chicago Wilderness region fall into three general categories: headwater, low-order, and mid-order. Within these groups are subcategories defined by flow, gradient, and substrate. The following is a brief description of each class and examples of streams within those classes.

Headwater streams

Continuous-flow headwater streams are first-order streams[1] with small drainage areas and little or no pool development. They are characterized by relatively stable, cool temperatures and consistent levels of dissolved oxygen. They have low habitat heterogeneity and low trophic complexity. Indicator fish species include sculpins and dace. Invertebrate indicator species include caddis flies and stone flies. Plants include watercress, chara, water parsnip, and berula. There are two general types of continuous-flow headwater streams: those with coarse substrates (e.g., Black Partridge Creek and Silver Creek) and those with fine substrates (e.g., Rob Roy Creek).

Intermittent-flow headwater streams are first-order streams with highly variable flows and temperatures. They are inhabited by colonizer species with high reproductive rates or are largely abiotic. Indicator fish species include bluntnose minnow and striped shiner. Intermittent-flow headwater streams can also be divided into those with coarse substrates and those with fine substrates.

[1] A first-order stream is a headwater stream without any tributaries. When two streams of the same order unite, the resulting stream is raised one level. Thus, when two first-order streams unite, the resulting stream is a second-order stream. When two-second order streams unite, the resulting stream is a third order. The order of a stream is not increased when a lover-order stream enters it.

Low-order streams

High-gradient low-order streams are second- to fourth-order, small- to medium-sized creeks, often with distinct riffle and pool development. They have more complex habitats and trophic characteristics than headwater streams. High-gradient low-order streams fall more than three feet per mile and have coarse substrates, mostly cobble, gravel, and sand with some silt. Indicator fish species include darters, stonerollers, hornyhead chub, and juvenile suckers. Examples include Tyler Creek, Buck Creek, and Long Run Creek.

Low-gradient low-order streams are second- to fourth-order creeks that fall less than three feet per mile and have predominantly fine-textured substrates. Indicator fish species include creek chub and bluntnose minnow; plants include sago pondweed, water star weed, and American pondweed. Examples include Lily Cache Creek, Skokie River, Plum Creek, and Mill Creek.

Mid-order streams

High-gradient mid-order streams are fifth- to eighth-order, large creeks to medium-sized rivers with relatively stable flows, temperatures, and high habitat diversity. They have the most complex habitats, are highest in species diversity, and harbor abundant predators. High-gradient mid-order streams fall more than three feet per mile and have coarse substrates. Indicator fish species include smallmouth bass, northern hogsucker, and redhorse. Examples include Kankakee River, Kishwaukee River, and the Lower Fox River.

Low-gradient mid-order streams differ from high-gradient mid-order streams in that they fall less than three feet per mile and have finer substrates. Indicator fish species include largemouth bass, pike, and channel catfish. Examples include the Upper Fox and the Upper Des Plaines River.

6.2.2 Functions of streams

Streams and rivers are familiar features in the Chicago Wilderness region. They perform many important functions, some obvious and some not so apparent.

Drainage is their most obvious function. Streams convey runoff from the land, most noticeably during floods, when even the least conspicuous drainageway can become a raging torrent. Streams also convey the treated and untreated wastes of our urban and agricultural lands. In fact, during the drier times of the year, treated wastewater constitutes virtually the entire flow in some of our more urban streams.

Streams also are valued for recreation because of their potential to support fishing, swimming, wildlife observation, and boating. Healthy streams provide habitat for diverse communities of fish, amphibians, insects, and aquatic plants. Stream and river corridors also are viewed as aesthetic amenities for residential development and public open space, and they provide travel corridors for wildlife.

Historically, however, conflicts have arisen between the various uses and functions of streams. In particular, increased reliance on streams as conduits for storm water and wastewater has greatly diminished their ability to provide benefits of recreation, habitat, water quality, and aesthetics.

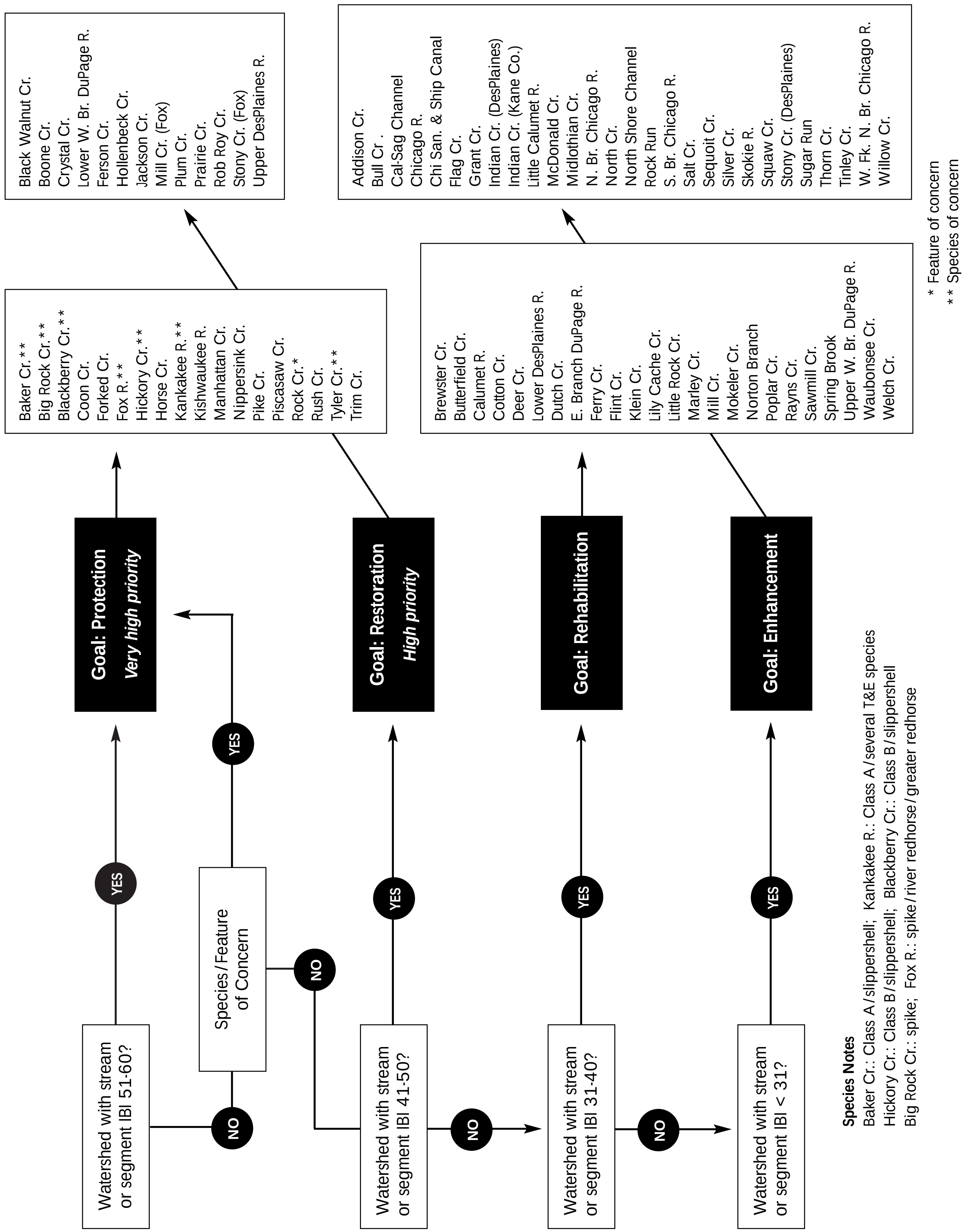
There are two principal causes for these conflicts. The first is the alteration or destruction of the stream channel and its adjacent corridor, or *riparian* zone. Activities such as stream channelization or straightening destroy critical habitat and upset the natural balance between a stream and its floodplain that has developed over thousands of years. The second cause is the alteration of the stream's watershed. For example, the conversion of farmland to subdivisions and shopping centers increases the impervious land surface. This can result in adverse changes to both the quantity and quality of stream-flow. These changes can upset the natural equilibrium of a stream, often resulting in channel erosion, lost habitat, degraded water quality, and frequent flooding.

6.2.3 Stream assessment and prioritization

One of the goals of the biodiversity recovery plan is to build consensus on the protection and enhancement of streams that provide a high degree of biological function. Watersheds of streams that have exceptional aquatic biological integrity, or have the potential to be restored, should be identified in order to establish priorities for future efforts in protection and recovery.

The information in this section results from a Chicago Wilderness project called "Stream Biodiversity Recovery Priorities." As a first step, the project identified perennial streams that support or have the potential to support native fish and aquatic life populations in the six-county northeastern Illinois region (Cook, DuPage, Kane, Lake, McHenry, and Will Counties) were identified. The project developed a stream prioritization method that classified streams into four categories according to the following recovery goals: protection, restoration, rehabilitation, and enhancement. Streams for which the goals are protection and restoration are considered of very high priority and high priority respectively. (See Figure 6.1.) The streams were classified by the following criteria:

Figure 6.1 Flow Chart for Determining Stream and Watershed Status



- Index of biotic integrity (IBI)
- Species or features of concern
- Macroinvertebrate Biotic Index (MBI)
- Abiotic indicators

The following describes each of these criteria and discusses their use and limitations in determining priorities for protection and recovery in the Chicago Wilderness region.

Index of Biotic Integrity (IBI)

The IBI uses fish-sampling data to indicate the overall health and integrity of a stream. The IBI assesses the health of fish communities using twelve different metrics. These twelve metrics fall into three categories: species composition, trophic composition, and fish abundance and condition. Data are obtained for each metric at a given site, and a number rating is assigned to each metric. The sum of the twelve ratings yields an overall site score, with scores in Illinois ranging from 12 for exceptionally poor quality to 60 for exceptionally high quality. The IBI integrates information about individuals, populations, communities, and the ecosystem into a single ecologically based index of water-resource quality (Karr 1981, Karr et al. 1986, IEPA 1996).

IBI data from Illinois were used to characterize streams. Streams with an IBI score of greater than 50 were designated as very high priority, with a primary goal of protection. Streams with an IBI score of 50 or less, but with species or habitat features of concern (described in the next section), were also designated as very high priority. Streams with IBI 41–50 that lacked species and habitat features of concern were designated as high priority, with a goal of restoration. Streams with IBI 31–40 that lacked species and habitat features of concern were assigned a goal of rehabilitation. Streams with IBI less than 31 that lacked species and habitat features of concern were assigned a goal of enhancement. Figure 6.1 shows the method for developing stream and watershed priorities and gives examples of watersheds for each category.

Species or features of concern

These include state threatened and endangered species as well as other unique aquatic habitat and biological characteristics. Professional experience and judgement were used in cases where fish and invertebrate data were unavailable, where unique cold-water habitats exist, or where unique fish and invertebrate communities were believed degraded because of point and non-point sources of pollution. Streams that contained species or features of concern were designated as very high priority, with the goal of protection. Table 6.1 gives a provisional list of stream-based species and features of concern.

Macroinvertebrate Biotic Index (MBI)

MBI values, based on pollution-tolerance ratings for macroinvertebrates, were compiled for streams where data were available. Streams with IBI scores of less than 40 and with MBI scores of less than five may indicate good-quality, healthy stream ecosystems that have some potential for restoration, rehabilitation, or enhancement. However, until a relationship between MBI and IBI values can be verified, other criteria must be used to assign goals for recovery and protection.

Abiotic indicators

For streams where biological data are extremely limited (for example, almost all headwater streams), abiotic watershed variables need to be considered in order to predict biotic potential and assign a recovery or protection goal. Abiotic watershed variables are frequently components of both aquatic *and* terrestrial ecosystems. Land-use patterns, percentage of impervious land surface, stream-flow obstructions, in-stream habitat, degree of erosion and sedimentation, degree of alteration and channelization, stream width, and substrate are all examples of abiotic factors affecting streams. Until these conditions can be adequately described and a prioritization method established, the assignment of recovery priority goals will rely primarily on professional judgement.

6.2.4 The relationship between stream quality and urban development

The biotic quality of streams and rivers in the Chicago Wilderness region is highly variable. As in other parts of the country, there is clear evidence that watershed urbanization has adverse impacts on the ecological integrity and beneficial uses of downstream bodies of water. In northeastern Illinois, this impact is reflected in a relationship between urbanization, as measured by watershed population density, and stream quality, as measured by the fish-based Index of Biotic Integrity (IBI). The assessment of over 40 northeastern Illinois streams and rivers shows that nearly all streams in urban and suburban watersheds (that is, with population densities exceeding roughly 300 people per square mile) exhibit signs of considerable impairment of their fish communities, with conditions being described as fair to very poor. In contrast, nearly all rural streams support fish communities that are rated good or excellent.

6.2.5 Long-term vision and recovery goals

The goals in this chapter focus on achieving a desired biotic integrity and biological diversity for streams of the Chicago Wilderness region. The goals provide the basis for actions, such as best management practices, informa-

Table 6.1
Stream Based Species Features of Concern

Mussels

Slippershell
Spike
Ellipse
Creek heelsplitter
Elephant-ear
Rainbow
Wavy-rayed lampmussel
Snuffbox
Higgins eye
Salamander mussel
Sheepnose
Pondhorn
Spectaclecase

Insects

Hine’s emerald dragonfly

Fish

Iowa darter
Western sand darter
Rainbow darter
Pallid shiner
Mottled sculpin
Blacknose shiner
Pugnose shiner
Greater redhorse
Banded killifish
Ironcolor shiner
Blackchin shiner
Weed shiner
Longnose dace
Brook lamprey
Pugnose minnow
Starhead topminnow
Banded darter
Bowfin
Spottail shiner
Brassy minnow
Largescale stoneroller
Creek chubsucker
Pirate perch

Amphibians and Reptiles

Spotted turtle
Smooth softshell turtle
Blanding’s turtle

Mammals

River otter

Plants

Heart-leaved plantain, *Plantago cordata*
Water marigold, *Bidens beckii*

Other Features

Streams with > 8 species of mussels
Other conditions that are known to harbor unique biological characteristics

tion and education activities, land acquisition, and other initiatives that would promote stream biodiversity, capacity, and resiliency.

We use the terms *protection*, *restoration*, *rehabilitation*, and *enhancement* to describe the recommendations for managing streams and watersheds. The following goal statements help define the terms as they are applied to watersheds throughout the region (see Figure 6.1 and Figure 6.2).

Protection is used for high-quality streams that fully support their potential biological integrity and diversity. Controlling point- and non-point-source pollution, channelization, impoundment, and other threats to biological integrity and diversity is necessary to assure that stream quality is maintained and *not degraded*. For example, if a stream is supporting a high-quality fish community or an endangered species, the goal is to protect those conditions.

Restoration is used for streams that are moderately degraded and only partially meet their potential biological integrity and diversity. Restoration seeks to replace lost or damaged biological conditions, restoring ecological processes and linkages (such as energy flow, dispersal mechanisms, and succession). For example, if a stream is supporting a moderate-quality fish community and is directly linked to a viable source of species recolonization, as is the Kankakee River, the goal is to restore the stream to a more diverse fish community by restoring lost habitat and improving degraded water quality.

Rehabilitation is used for streams that are more severely degraded and do not meet their potential biological integrity and diversity. The goal here is to replace some of the lost or damaged biological functions and linkages of the stream. For example, if a low-quality fish community retains some functional linkage to a viable source of recolonization, the goal is to re-establish some biological integrity by partially restoring some habitat or water-quality components.

Enhancement is used for streams that are the most severely degraded. The goal is to reclaim severely damaged ecosystems. For example, if a very poor fish community has no functional linkage to a source of recolonization, the goal is to mitigate the sources of degradation in the stream, but to recognize that this will only have a limited effect on biological functions.

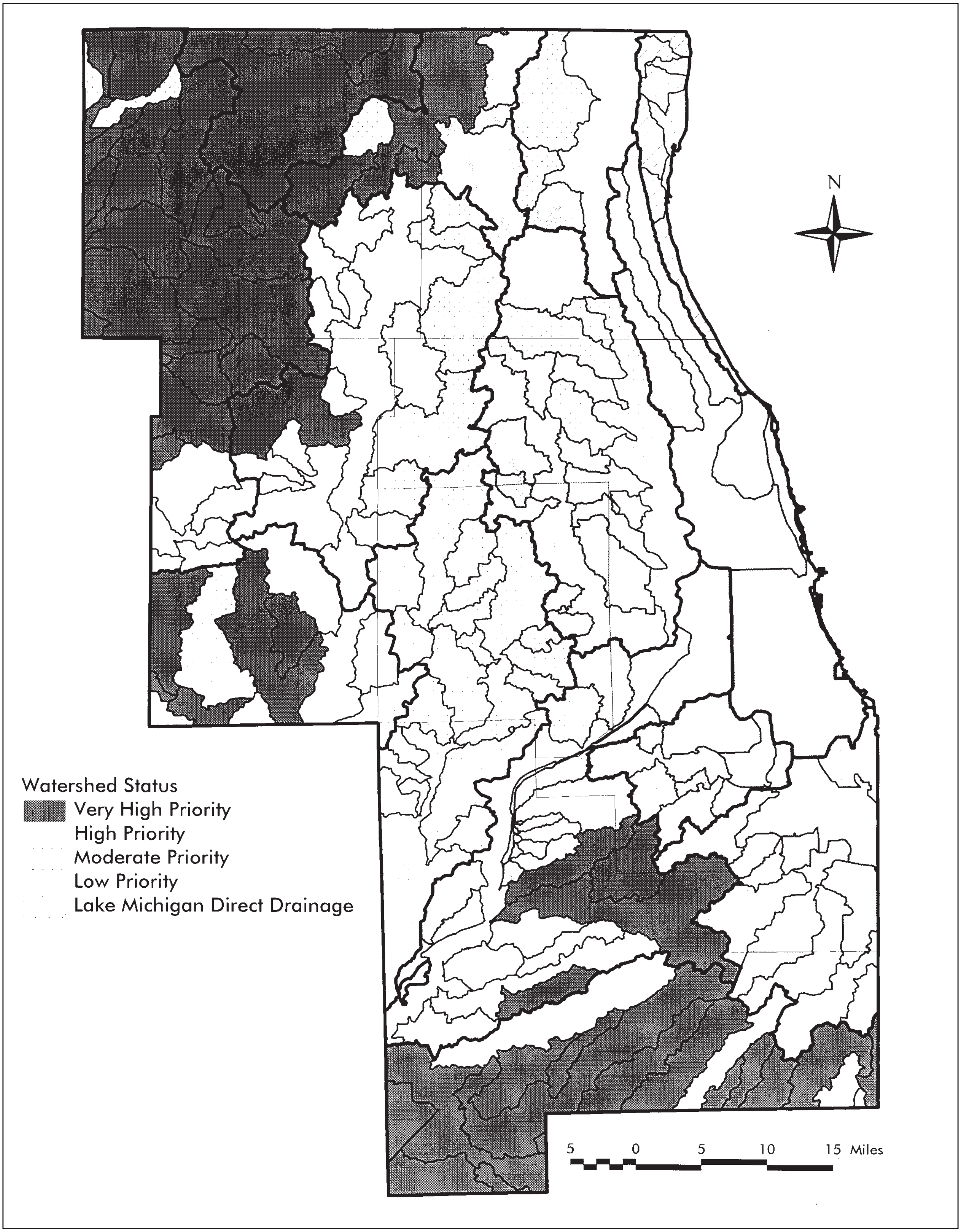


Figure 6.2 Priority watersheds in northeastern Illinois.

6.2.6 Threats

As watersheds undergo development, land is covered with impervious materials (such as pavements and rooftops) or surfaces that limit infiltration (such as cultivated fields and areas with shallow-rooted plants). As a result, storm-water collects on or near the surface. Groundwater recharge areas are restricted and surface runoff becomes the principal source of stream flows. The result is “flashier” streams that are prone to flooding and severe erosion. Watersheds with greater than 10%–15% impervious surface area tend to produce degraded stream habitat and biodiversity (Center for Watershed Protection 1998a). In addition, drainage of wetlands and other low-lying storage areas and channelization of streams alter a watershed’s hydrology and reduce aquatic biodiversity.

Based on watershed assessments of impaired streams, both point and non-point sources of pollution are major contributors to impairment. While point sources, particularly municipal wastewater-treatment plants and combined sewer overflows, generally contribute the greatest pollutant loads to most urban rivers and streams, dramatic reductions in the concentration of pollutants in discharges have occurred in the last two decades. Impairments from non-point-source pollution are substantial and are actually increasing in many watersheds due to expanding suburban development in the region. Thus, a major challenge is to better control the impacts of development-related non-point-source pollution to protect the region’s remaining high-quality streams.

Runoff from residences, businesses, construction sites, and industries carries sediment, nutrients, pesticides, metals, grease, oil, bacteria, salts, and debris to nearby streams. Runoff from agricultural areas carries similar pollutants but at different rates and concentrations. Losses in dissolved oxygen and thermal pollution are other water-quality problems associated with human impacts on streams and watersheds.

As development occurs, streams are often impounded, straightened and channelized, the banks sometimes armored with concrete or stripped of native vegetation—all to accommodate buildings, roads, flood control and storm-water conveyance systems. The resulting stream habitat degradation severely limits aquatic life, encourages exotic species, and reduces healthy biodiversity.

6.2.7 Recommended actions

- **Reduce hydrological alteration**

✔ **Continue to identify watersheds with streams that have exceptional aquatic biological integrity to inform planning efforts and set priorities.**
This chapter describes a technique, using well-established indicators, for classifying streams according to their biological integrity and suggests priority goals for protecting or restoring their biodiversity. This process has been applied to the streams in the Illinois portion of the Chicago Wilderness region but should be extended to cover the entire region, so that priorities can be set at the regional level.

✔ **Limit development in some high-priority subwatersheds.**
Recent research has shown that the amount of impervious cover in a watershed can be used to project the current and future health of many headwater streams. There also is strong evidence suggesting that impervious cover is linked to the quality of other water resources such as lakes, reservoirs, and aquifers (Center for Watershed Protection 1998b).

✔ **Direct development into areas that limit hydrological alteration.**
Many model land-development principles have been documented to limit adverse storm-water impacts and to benefit both the stream environment and the community. These principles involve the careful location and design of residential streets, parking lots, building footprints, and conservation areas (Dreher and Price 1994).

✔ **Promote cluster development.**
Cluster development uses smaller lot sizes and less pavement to minimize impervious area, reduce construction costs, conserve natural areas, provide community recreational space, and promote watershed protection. Relaxing side-yard setbacks, allowing narrower frontages and shared driveways, and providing shared parking arrangements are all techniques for cluster development.

✔ **Require storm-water detention that effectively controls the full range of flood events.**
Local standards for storm-water ordinances are usually intended to prevent increases in flood damage. Drainage and detention facilities should be

designed to minimize runoff volumes and rates, so that the natural hydrologic and water-quality functions of streams, wetlands, and floodplains are protected.

✔ **Promote natural drainage as an alternative to storm sewers.**
Where density, topography, soils, and slopes permit, open vegetated swales and constructed wetlands should be used to temporarily detain, convey, and treat runoff from a range of storm events. New storm-water outfalls should not discharge unmanaged storm water into jurisdictional wetlands, aquifers or sensitive areas.

✔ **Create buffer strips and greenways along streams.**
Riparian stream buffers are variable-width strips of land continuously vegetated with native plants. They encompass environmental features such as wetlands, steep slopes, the 100-year floodplain, multiple-use greenways and trails, wildlife corridors and additional safety widths adjacent to high-impact, high-density development. Buffers should be maintained throughout the stages of plan review, construction, and post-development.

✔ **Acquire additional land for conservation.**
Results of open space referenda in several Chicago Wilderness counties showed that the public generally supports acquisition of new parks and forest preserves for multiple benefits, including recreation, aesthetics, wildlife habitat, clean air, and clean water. Additional open space, with its protection of trees and other deep-rooted vegetation, enhances storm-water infiltration and groundwater recharge, and it can help to mitigate damages caused by flashy stream flows.

✔ **Develop storm-water management plans.**
Storm-water management plans establish a framework of standards for minimizing storm damages to structures, public health, and safety. They should identify, protect, and improve waterways and groundwater recharge areas by requiring all new development to minimize or reduce storm-water damages. The plans should protect and improve water quality, promote public awareness of storm-water issues, and identify revenue sources for the adopted program.

✔ **Enforce erosion-control measures on new construction.**
Many effective practices for controlling erosion and sediment have been developed specifically for use on construction sites. Developers and local officials should work together to choose the best techniques to minimize off-site sedimentation. For this to happen, building inspectors, contractors, and engineers must all understand the principles, benefits, and limitations of best management practices for erosion and sediment control.

✔ **Create or restore streamside wetlands.**
Streamside wetlands are complex ecosystems that provide many ecological functions beneficial to their adjoining streams. They are biologically productive systems that provide fish and invertebrate habitat, water pollution control, sediment control, water supply, floodwater storage, and barriers to erosion. In addition, streamside wetlands provide habitat for threatened and endangered species such as the spotted turtle and river otter.

✔ **Educate decision-makers about development patterns and the effects of land uses on streams.**
Elected officials and local governments should be aware of model watershed-development principles and how they apply to their watersheds. Officials should evaluate their zoning codes and subdivision ordinances based on those principles. The Center for Watershed Protection (1998a) gives details on model development principles.

• Reduce deterioration of habitat quality

✔ **Remove unnecessary dams.**
Many dams in the region impede the movement of fish and other aquatic life up and down the waterway. Consequently, high-quality streams sometimes abruptly deteriorate above or below a dam. Where dams are not needed for water supply, flood control, or recreation, they should be removed or fitted with structures that effectively permit the passage of aquatic species. By removing a dam, the owner can often eliminate the cost of repairing the dam while improving the stream's biodiversity.

✔ **Retain or restore emergent and near-shore vegetation.**
A thriving, diverse vegetative community is an important component of a functioning stream or streamside wetland. If a degraded stream's hydrology and water quality can be stabilized, vegetation can be re-established by planting seedlings, root stocks, bulbs, or transplants. Native plant species should be used in riparian areas to protect and restore important functions such as bank stability, wildlife habitat and forage areas, runoff filtering, and shading. The choice of native plants depends

on local needs and conditions. The USDA (1997) has published information on local species that are best adapted for stream conditions.

✔ **Re-meander channelized streams.**
Meanders are naturally occurring bends in a stream that help dissipate energy of flowing waters. They create a variety of flow velocities and provide important habitat features for some aquatic species. There are many opportunities to recreate meanders in artificially straightened streams in the Chicago Wilderness region.

✔ **Restore riffles, pools, sandbars, and other elements of in-stream habitat.**
A riffle is a shallow rocky area that separates deeper pools in a stream. Riffles enhance water aeration while providing habitat for many aquatic species such as darters and stoneflies. In channelized streams, riffle sequences are typically diminished or eliminated altogether. Sandbars and mud flats provide valuable habitat for a variety of birds and invertebrates.

✔ **Study the effects of riparian management.**
Unfortunately, relatively little monitoring has been conducted on managed riparian lands. Experimental model projects, such as the one at Mellody Farm Nature Preserve on the Middle Fork of the North Branch of the Chicago River, should be carefully studied to evaluate the biodiversity benefits to the stream.

✔ **Survey how people use aquatic resources and study the economic impacts of uses such as fishing and recreational boating.**
Surveys, like the one conducted by the Chicago River Demonstration Project, should be taken to help describe and understand how user and interest groups currently perceive and use streams of Chicago Wilderness, and how they would like to see the corridors improved for recreation and related values.

✔ **Use bioengineering solutions to control streambank erosion.**
Bioengineering methods combine live plant materials with built structures to stabilize eroding stream banks, resulting in a living and sustainable erosion-control system. By using native plant species and with considerable care and maintenance in the first few years, bank stabilization can become self-sustaining and, to an extent, self-repairing since the plants are adapted to growing and reproducing in the stream environment.

- ## Reduce deterioration of water quality

✔ **Rigorously enforce non-degradation standards.**
Pollution-control agencies such as the Illinois Environmental Protection Agency (IEPA) have been criticized for failing to adequately enforce rules that prohibit adverse impacts of discharges on streams as called for in the Clean Water Act. Effective anti-degradation policies and enforcement procedures will ensure that pollutant levels in wastewater and storm-water discharges do not exceed levels that are damaging to stream biodiversity, especially in high-quality streams.

✔ **Develop and implement best management practices to control soil erosion, sedimentation, and storm water runoff.**
Effective efforts to protect streams and their watersheds usually include the use of best management practices. These are actions or structures that are needed to control runoff pollution and flooding. Examples of some commonly used practices are use of vegetative buffers, streambank stabilization, wetland creation or restoration, use of grassed swales or waterways, sediment basins, diversions, keeping streams above ground, remeandering streams, and wildlife plantings.

✔ **Find alternatives to new and expanded effluent discharges to high-quality streams. For example, route sewage flows to regional facilities and use land treatment.**
Organic matter, nitrogen, phosphorus, and micronutrients in storm water and wastewater are generally harmful when discharged to high-quality streams and lakes. Land treatment systems and detention facilities should be designed to ensure that pollutants do not reach streams, especially high-quality streams.

✔ **Re-examine standards and practices for sewage treatment.**
There is a need to establish sewage-treatment policies that ensure protection for high-quality streams and that allow restoration of low-quality streams. While improvements to sewage-treatment plants have improved quality in degraded urban streams, the same standards and discharge limits are proving insufficient to protect high-quality streams in non-urban areas. Aging sewage- treatment facilities eventually develop structural problems or worn-out mechanical systems that are difficult or uneconomical to replace. Plant managers should, to the extent of their authority, assess downstream aquatic biodiversity when determining how to meet permit limits and water-quality standards for pollutant

removal and when establishing policies for new plants and updated equipment.

✔ **Promote effluent polishing through constructed wetlands for all discharges to moderate- and high-quality streams.**
Wastewater effluent should not be directly discharged to streams, especially high-quality streams. Instead, treatment trains should include tertiary constructed wetlands or provide reuse options such as irrigation, industrial processing, groundwater recharge, fire protection, and / or limited-contact recreation.

✔ **Encourage pollution-control regulators to use biocriteria for water quality standards.**
Biocriteria are measures of the quality of streams based on living organisms. Standards for pollution discharges are based on the impact of the discharge on these living elements. Water-quality metrics used by the Illinois Environmental Protection Agency, for example, do not recognize the graded continuum of stream systems and do not give recognition to unique areas of biodiversity. The state of Ohio, on the other hand, has developed a set of metrics that have given a higher measure of protection to many of the high-quality streams there.

✔ **Gain community support for watershed management.**
Watershed planning and management are perhaps the most important stream-protection tools. Management plans should be developed with community consensus on the goals for water resources and the techniques and practices needed to meet those goals. Techniques may include overlay zoning, cost-share incentives, growth boundaries, and conservation easements. See Section 0 (especially 8.3.3) for further discussion.

✔ **Evaluate aquatic insects as indicators of water quality.**
The presence or absence of indicator organisms is an indirect measure of water pollution. Benthic macroinvertebrates, including aquatic insects (such as mayflies, stoneflies, caddisflies, midges, and beetles), snails, worms, freshwater clams, mussels, and crayfish are sensitive to changes in a stream's ecological integrity. However, the relationship between benthic macroinvertebrates and other water-quality indicators, such as fish and water chemistry, has not been clearly established.

✔ **Encourage volunteer monitoring.**
In the State of Illinois, the goal of the Critical Trends Assessment Program to track changes in stream habitats over time can only be met with a combination of volunteers and scientists working in collaboration. Volunteer monitors enable the state to collect large amounts of information economically, and this information is providing an important bank of knowledge about local conditions in streams and other ecosystems. Currently, there are unlimited opportunities for volunteer monitors to become trained citizen scientists through the Illinois EcoWatch Network.

The Northeastern Illinois Planning Commission (1998) further explains some of the actions described above. This handbook addresses landscape buffers, channel maintenance, stream bank stabilization, and techniques for restoring in-stream habitat.

6.3 Lake communities—status, recovery goals, and recommended actions

6.3.1 Lake classification

In addition to Lake Michigan, three types of natural lakes occur in the Chicago Wilderness region: bottomland lakes, vernal ponds, and glacial lakes. *Bottomland lakes* are shallow lakes adjacent to large streams and are seasonally flooded. There is seasonal recruitment of species in bottomland lakes. *Vernal ponds* are small, seasonally inundated depressions that have no fish species. *Glacial lakes* are divided into two types: kettle and flow-through. *Kettle lakes* are isolated basins, while *flow-through lakes* are connected to a stream system. Glacial lakes are the most biologically diverse of the lake types. In addition to the natural lakes, the region has a number of manmade lakes.

In planning for biodiversity recovery, the classification system for lakes is less useful than the terrestrial classification system. The glacial lakes are the most ecologically important of the lakes, and are thus the primary focus for conservation attention, although other lakes do contribute to the region's biodiversity. To help establish priorities for conservation efforts and recovery goals, a working group for lake recovery plans developed a system to assess the status of the lakes' biodiversity.

6.3.2 Lake assessment and prioritization

The method to assess the current condition of biodiversity in the region's lakes is in part based on Vermont's system (Garrison 1994–1995). This system defines four categories for lakes. The categories are intended to be operational and to promote various conservation actions for the region's lakes, rather than to be rigid or restrictive. The four categories are *exceptional*, *important*, *restorable*, and *other*. The criteria used to place various lakes in a category are driven solely by the biodiversity in the lake. We recognize that other features of lakes such as water quality are important indicators of environmental quality, but we believe that biodiversity provides the most direct measure.

The criteria for the lake status assessment are as follows:

Exceptional lakes

- Must have threatened or endangered species of flora or fauna
- May have other watch species
- Have more than eight native plant species and more than 14 native fish species.

Important lakes

- Have more than eight native plant species and more than14 native fish species
- May have exotic species present, but not dominant
- May have watch species
- According to historic records, have had threatened or endangered species of flora or fauna

Restorable lakes

- According to historic records, have had threatened or endangered species of flora or fauna
- Are glacial lakes with physical characteristics that would support reintroduction of endangered and threatened species
- May be currently dominated by exotics that could be controlled with appropriate management

Other lakes

- Are unlikely to support sensitive species and may be better managed for purposes other than biodiversity conservation.

We conducted a preliminary assessment of the region's lakes. Tables 6.2 and 6.3 show preliminary results for exceptional and important lakes. Information used for this assessment includes data from the Illinois Natural Heritage Database, the Illinois Department of Natural Resources, The Nature Conservancy, and the McHenry ADID study, as well as expert opinion. It should be noted that the data used did not include information on native plant species present, and in some cases numbers of native fish species are not recorded. In cases where complete information was not available, scientist and land managers made a determination based on what they did know about the lake. As new information becomes available, the status of the lakes may change.

Table 6.2

Preliminary Assessment Showing Exceptional Lakes

County	Lake Name	No. of Native Fishes	No. of E/T Species
Cook	Wolf Lake	28	5
Lake	Bangs Lake	22	5
Lake	Cedar Lake	27	9
Lake	Cross Lake	>14*	5
Lake	Deep Lake	18	5
Lake	Deer Lake-Redwing slough	>14*	1
Lake	East Loon Lake	23	5
Lake	Fourth Lake	>14*	2
Lake	Gray's Lake	15	2
Lake	Timber Lake	>14*	1
Lake	Lake Catherine	21	1
Lake	West Loon Lake	23	8
Lake	Mud Lake	>14*	1
Lake	Petite Lake	17	1
Lake	Sullivan Lake	>14*	2
Lake	Sun Lake	>14*	1
Lake	Turner Lake	22	1
Lake	Wooster Lake	>14*	3
McHenry	Crystal Lake	23	2
McHenry	Elizabeth Lake	19	6
McHenry	Lake Defiance	18	1
McHenry	Lake Killarney	19	2
McHenry	Lily Lake	16	2

* For these lakes, data on number of native fishes was not available, but experts at the workshop expect high native fish diversity based on overall lake condition.

Table 6.3
Preliminary Assessment Showing Important Lakes

County	Lake Name	No. of Native Fishes
Cook	Axehead Lake	14
Cook	Beck Lake	16
Cook	Busse Woods Lake	22
Cook	Maple Lake	15
Cook	Marquette Park Lagoon	16
Cook	Midlothian Reservoir	15
Cook	Tampier Lake	18
DuPage	Mallard Lake	18
DuPage	Pickerel Lake	18
DuPage	Silver Lake	18
Lake	Channel Lake	22
Lake	Diamond Lake	20
Lake	Fox/Nippersink	23
Lake	Gages Lake	22
Lake	Lake Marie	22
Lake	Lake Zurich	22
Lake	Long Lake	21
Lake	Old School Pond 2	20
Lake	Pistakee Lake	18
Lake	Sand Lake	14
Lake	Sterling Lake	25
McHenry	Griswold Lake	18
McHenry	Lac Louette	16
Will	Braidwood Lake	38
Will	Lake Milliken	19

6.3.3 Long-term vision and recovery goals

Exceptional lakes: The vision for these lakes is to manage all of them for maximum aquatic biodiversity. This will include allowing native vegetation to dominate shorelines and keeping littoral-zone disturbance to a minimum. A goal is for no exceptional lake to lose any native species, particularly endangered or threatened species. Over time, the number of exceptional lakes should increase due to improvement in the condition of important lakes, yet none of the exceptional lakes should decline in condition. A goal is to manage exceptional lakes as part of their watershed. To achieve this, watershed plans should be developed, implemented, and changed as needed to maintain the exceptional status of a lake. To help achieve these goals, all historical biodiversity data should be retained. Additionally, the state laws on endangered and threatened species should be strengthened to provide adequate protection for these aquatic species. More research is needed on the life histories of endangered and threatened aquatic species. For priority species, specific recovery plans should be developed and implemented.

Important lakes: The goals for these lakes are similar to the goals for exceptional lakes. The vision for important lakes is to improve their condition so that most of the important lakes move up to the category of exceptional lakes. Management plans need to be implemented not only to improve the conditions of these lakes but also to prevent them from falling into a lower category. A goal is to have landowners value the natural state of a shoreline and play an active role in conserving and preserving lakes.

Restorable lakes: For these lakes, the goal is to control invasive species and sources of impairment effectively. Many of these lakes can and should be restored to the point where endangered and threatened species can be reintroduced. With proper restoration efforts, native species should be surviving the challenge of exotics. A goal is for most restorable lakes to move up to the category of important lakes through restoration efforts. Demonstration projects that clearly show how it is possible to restore a lake to exceptional condition should be conducted as part meeting this goal. The goal of restoration efforts is to return lakes to a condition in which they can retain their historical native species.

Other lakes: Lakes that are not viewed as restorable (from a biodiversity perspective) should provide recreational and cultural services that do not jeopardize the biodiversity goals of other lakes. These lakes may serve important educational purposes, and natural habitats should be encouraged in these lakes. A goal for these lakes is to have all of them contribute positively to their watershed's overall quality, either through water-quality or storm-water management. Fisheries management needs to be better understood, and anglers and other recreational users should have a better understanding of the importance of biodiversity. The goal is for the public to understand the limitations of a finite resource and to adjust their expectations accordingly.

6.3.4 Threats

The most severe threats to lakes are invasive species, nutrient loading, sedimentation, loss of native submerged and emergent vegetation, and management actions focused on only a narrow range of species (such as game fish). While invasive species, hydrologic change, and loss of native vegetation are common threats to both aquatic and terrestrial systems, aquatic communities are much more sensitive to sedimentation, toxic substances, and excess nutrients.

Problematic invasive species include Eurasian water milfoil, carp, and zebra mussels. Species most often invade lake communities either through human introduction (knowingly or not) and through hydrological connections. Therefore, lakes without significant public access and with few or no hydrological connections are more resistant to invasion than other lakes.

Nutrients enter lakes through a variety of sources. These sources include effluent from sewage-treatment plants, agricultural runoff, lawn fertilizers, and waterfowl.

Causes of erosion resulting in turbidity and sedimentation include carp, shoreline development, upland development, agricultural runoff, and other man-made disturbances.

Submerged and emergent vegetation can be lost either through turbidity and siltation, deliberate removal, shading by excess algae caused by nutrients, or from the effects of invasive species. The loss of submerged vegetation is particularly important, because of its value as habitat for fish and other organisms and its role in settling sediments.

Different from terrestrial communities, which are significantly threatened by the lack of management, lakes often suffer from narrowly focused management activities, which are generally not aimed at protecting biodiversity. Lakes are often “managed” for recreational purposes or for particular species of game fish. This type of management tends to disregard biodiversity and hence becomes a threat to the region’s lake communities. For recreational reasons, native aquatic plants are often removed either through harvesting or herbiciding, which can be extremely detrimental to biodiversity. These activities are particularly damaging to the littoral zone. Water-level manipulation and dredging, if done solely for recreational purposes, are also very damaging to the lake biodiversity. Recreational motor boats and jet skis are also problems because they create waves and turbulence in excess of natural frequency and intensity. This affects both shore erosion and the bottom in shallow areas. Additionally, motor boats and jet skis disrupt lakebed and shoreline soils, require large open-water areas that are often created by removing emergent vegetation, and harm the vegetation that does remain.

When fisheries are managed for a few particular species or when there are uncontrolled levels of stocking, the overall lake biodiversity often suffers.

Lakes also face several other threats. Lake hydrology is often interrupted through disconnection between lakes and other hydrological breaks. The introduction into lakes of contaminants, such as heavy metals, pesticides, and salt, has detrimental effects on the biodiversity. Finally, the loss of vegetation and overhanging canopy around a lake can lead to loss of essential habitat and fish species.

6.3.5 Recommended actions

Lakes are very different from the terrestrial communities in Chicago Wilderness, in that most lakebeds are largely in private ownership. Consequently, conservation of lake biodiversity cannot be focused just on the efforts of the Forest Preserve and Conservation Districts and other land-owning public agencies. Some specific actions can be taken to manage directly for biodiversity. Some management needs will require additional research and an adaptive management approach. However, the fate of lakes lies more directly in the hands of the private citizen. Therefore, there are numerous recommendations to improve conservation of lake biodiversity through both regulations and volunteer activities by the public. Both regulation and incentive tactics will require better knowledge of the laws and issues by the general public. Creating a balance among the multiple uses of lakes is an overarching need and goal of many recommended actions. Progress can be made in reaching this balance through better guidelines and laws regarding human activities around and in lakes. Most important, extensive public education and communications are needed to create a heightened awareness of issues affecting lake biodiversity.

Recommendations

✔ **Develop specific recovery plans for species and lakes of concern**

It is recommended that recovery plans for specific species be developed and implemented. Some priority species for specific recovery plans include pugnose shiner, fern pondweed, white-stemmed pondweed, water star grass, grass-leaved arrowhead, and water celery. Of all the fish species, pugnose shiner serves as a good indicator species; if recovery actions restore viable populations of pugnose shiner, then other species will be helped as well. In addition to specific species, recovery plans for specific lakes are recommended. A first step is to develop criteria to identify priority lakes for lake-specific recovery plans.

✔ **Develop better mechanisms to control the invasion of exotic species**

Better control mechanisms are needed for invasive species, particularly Eurasian water milfoil and carp, and this will require research. Biological controls such as beetles and weevils to control Eurasian milfoil hold promise as the best long-term solutions, but great care must be taken to prevent introduction of controls that could themselves become problems.

✔ **Plan, protect, and manage lakes at the watershed level**

For exceptional and important lakes, opportunities for public acquisition of shoreline and upland areas should be identified and prioritized. Critical watershed areas also should be identified. In general, lakes should be managed as part of their watershed, and watershed-planning efforts should account for the biodiversity needs of lakes.

✔ **Develop a region-wide database to track and study threats to lakes**

A region-wide recording system should be developed that stores information about the types of pesticides being used in the region and specifically where they are applied. The system should also track the status of lakes. These records are needed to better understand the threats to lakes and to adapt management and policy accordingly.

✔ **Conduct research to better understand habitat requirements of aquatic species**

To better manage for fish diversity, more research is needed on environmental partitioning by fish species. There is more to learn about how fish use their habitat. Additionally, very little is known about the status and habitat requirements of many invertebrate and algae species. To manage for biodiversity, more information is needed on these poorly understood species.

✔ **Investigate and mitigate the threat of salinization**

While salinization is a known threat to lake communities, more research is needed on the specific effects and impact thresholds of salt on lake biodiversity. Until more is known about the effects of salt, the general practice should be to minimize loading of salt to lakes, especially those not having outlet flows that relieve accumulation.

✔ **Investigate and prepare for the possibility of reintroduction of native species**

As conditions of restorable lakes are improved to the point where they can support a variety of species, it is recommended that species be reintroduced to these lakes. However, protocols and models should be developed to ensure that reintroductions will be effective and efficient.

✔ **Strengthen laws protecting species and their habitats**

Laws on endangered and threatened species need to be strengthened and enforced to provide adequate protection for these species. Another recommended action is to legally require naturally vegetal shoreline zones, at least in critical watersheds. The exceptional lakes are of particular importance to the conservation of the region's aquatic biodiversity. Therefore, rules and regulations to limit uses of the exceptional lakes warrant additional discussion.

✔ **Integrate biodiversity concerns into laws, policies, and guidelines**

State laws, particularly those dealing with the use of pesticides and herbicides, need to be improved to integrate biodiversity issues. State policies on aquatic-plant management should ensure that plant management both respects property rights and encourages diverse plant communities. Guidelines for land-use planning that recognize biodiversity and improve water quality should be developed. In general, biodiversity concerns need to be much more broadly incorporated into land-use and wastewater-treatment plans. Model ordinances for alternative development around lakeshores should be enhanced and promoted, and conservation easements around shorelines should be promoted. In short, alternative methods that reflect biodiversity needs should be enhanced and presented to the public. Additionally, Chicago Wilderness should work directly with municipal governments in lake areas.

✔ **Clarify ambiguous laws relating to lakes and their management**

One particularly problematic legal issue is Illinois's water law. How this law relates to water use, ownership, and management is unclear and inadequate. There are numerous legal interpretations of the law, and this confusion currently stands in the way of restorative issues and actions. It is recommended that Chicago Wilderness take a leading role in working to help resolve this issue.

✔ **Increase public understanding of lake biodiversity issues**

For the conservation of lake biodiversity, the most important action is to balance human uses with ecosystem constraints. Public recognition of the value of lake biodiversity and appreciation that lakes are a limited resource will be important to achieving conservation goals. Recreational and other human uses must not exceed what lakes can support. As a first step, the negative environmental impacts of development, recreation, and misuse should be documented, as well as the positive effect of management practices. Public information and education should make these well known, particularly to lake association members and other potential supporters. Revisions to incentives, programs, laws, and regulations should then follow together with appropriate public hearings.

✔ **Increase public involvement in lake management and protection**

There are already a number of volunteer lake monitors and stewards, but their numbers should be expanded, not only to increase the amount of data collected and the number of lakes monitored, but also to create a broader network of people knowledgeable about lakes. It is recommended that Chicago Wilderness promote cooperation and communication among lakefront owners and users. Active lake users need to learn the full impacts of their collective uses of the lakes on biodiversity and realize the ecological limits to their uses. Lake-use plans that offer a range of recreational uses consistent with a balanced, diverse ecosystem need to be developed. Development of these plans will require the input of knowledgeable citizens and consumers. Additional funding for biodiversity conservation and non-consumptive uses should be generated, at least in part, from consumptive uses of the lakes.

6.4 Near-shore waters of Lake Michigan

Lake Michigan is a vast aquatic ecosystem in its own right, and its near-shore waters in the Chicago Wilderness region function primarily as part of that system. However, they are an important part of Chicago Wilderness, both in their impact on adjacent ecological communities and intrinsically as an important ecological community. Lake Michigan provides climatic diversity and supplies sand to nourish its changing beaches and dunes. The seasonal and year-to-year changes in water level support lakeshore wetland communities. Its near-shore waters provide habitat for many fish and other aquatic species and are used by migrating waterfowl and shorebirds.

Much of the shoreline in the Chicago Wilderness area has been filled for buildings, parks, and marinas, eliminating coastal wetlands. The areas that remain in near-original condition tend to be beaches with relatively high-energy wave systems and relatively little organic substrate to support ecological communities. Structures installed to protect harbors and lakefront development have in many cases interrupted movement of sand or deflected it into deep water where it is lost from the beach-nourishment process.

The fish communities are in a state of flux due to many changes throughout Lake Michigan. Major factors include:

- historic invasion by lamprey and alewife and introduction of Pacific salmon
- excessive fish harvest
- recent invasion by zebra mussels, which are changing abundance and species mix of algae and zooplankton (including algae that create taste problems in drinking water)
- ongoing invasion by gobies and other species

Historic problems with excessive nutrients, acute toxicity, and floating materials have been solved, but problems with persistent toxic substances that bioaccumulate in fish are still a problem for human health, although effects in the ecosystem are not apparent.

Wanton filling of shallow areas and gross pollution has ended, but care must be taken not to allow additional filling and not to allow structures that interrupt currents and supplies of sand. A major current fishery problem is the decline of lake perch, which is being addressed by the fish-management agencies in the respective States.

There are opportunities that should be addressed locally to restore aquatic habitat and biodiversity in some sheltered areas such as harbors, river mouths, and lagoons. Even intensely urban settings offer opportunities to create incidental habitat while designing projects focused on other purposes such as shore stabilization or brown-field redevelopment.